6.4.5 Objective 5: Effects of Pollutants on Visibility, Atmospheric Acidity and Mutagenicity

Project 5.1: Visibility Case Studies and Extinction Budgets. Calculate the refractive indices for different aerosol samples and determine the effect of variations in these indices and in particle size distributions on extinction efficiencies. Include the measured fraction of liquid water in these calulations and compare the results with calculations which neglect liquid water or infer it from RH measurements. Repeat these calculations for internal and external mixtures, and compare the differences with these variabilities. Examine single particle analyses of selected samples to determine the degree of internal and external mixing in the aerosol population. Determine the extinction efficiency of each particle type, and estimate the contribution of each type to the total light extinction. Calculate extinction due to Raleigh scattering, scattering using the chemical-specific size distributions, absorption by elemental carbon, and NO_2; and compare the total to the scattering and absorption measurements. Identify cases of disagreement between theory and measurement which exceed estimated uncertainties and ascertain which deviations from assumptions are causing those disagreements. Calculate visibility reduction via linear regression analysis (e.g. White and Roberts, 1977) and compare the inferred scattering efficiencies with the theoretical scattering efficiencies. Calculate the relative contributions from fine and coarse particles, particles and gases, and primary and secondary species. Identify meteorological characteristics which might cause different spatial and temporal distributions of visibility impairment.

Project 5.2: Case Studies of Atmospheric Acidity. Examine the spatial and temporal nature of atmospheric acidity and relate strong acid concentrations to sulfate, nitrate, and other ionic components in the aerosol and gas phases. Coordinate with Project 3.1 to determine differences between wet and dry oxidation mechanisms and ascertain whether or not significant differences in atmospheric acidity exist between these pathways. Compare measured acidity levels with those determined by chemical equilibrium models and determine which chemical and physical variables are required to make accurate equilibrium calculations. Apportion the acidity among the gas, particle, and droplet phases.

Project 5.3: Case Studies of Atmospheric Mutagenicity and Toxic Species. Determine which organic toxic air contaminants are present at different sites and times using the displays of Project 1.1, and compare these levels with those found in other urban areas and with levels which have been found to be harmful. Identify areas in the SOCAB where levels are consistently higher than in other areas, and examine the source emissions maps and wind flow patterns to estimate their potential origins. Identify which species are of primary or of secondary origin.

6.4.6 Objective 6: Accuracy, Precision, and Validity of Measurement Methods

Project 6.1: Evaluate Measurement Methods. Use the data from the ARB-sponsored nitrogen (Hering et al., 1987a) and carbon comparison studies (Hering et al., 1987b), SCAQS data obtained by multiple techniques, and SCAQS data obtained by duplicate measurements using the same techniques to assess the accuracy, precision, and validity of the SCAQS sampling methods for acidic species, organic and inorganic carbon species, particle liquid water measurements, labile species measurements, and particle size measurements. Quantify differences between methods by non-parametric statistical tests, comparisons of uncertainty intervals, and linear regression analysis. Attribute differences between measurement methods which exceed precision intervals to standardization, interferences, sample validity, or other causes.

Project 6.2: Estimate Uncertainty of SCAQS Measurements. Combine the data from simultaneous measurements of the same observable by different methods and the results of measurement evaluations to quantify the variability about the measurement which would be found in a representative volume around the sampling point. List all of the assumptions which must be met by each measurement method in order to yield a valid value, and identify those periods of SCAQS sampling in which those assumptions were not complied with. Quantify the effects of deviations from these assumptions wherever possible.

6.5 COMPLEMENTARY MODELING PROJECTS

Although air quality modeling is not an integral part of SCAQS. The study has been designed to meet modeling needs. Several sponsors already have planned modeling uses for the SCAQS data and have made their data needs known during the planning process. These needs have been accounted for in this plan. In addition, the Model Working Group (MWG) was established to provide continuing technical input to the SCAQS design parocess. The MWG has served as an interface to the modeling community to assure that SCAQS data will be appropriate for modeling projects and to coordinate the modeling efforts of various participants.

The MWG has reviewed the current status of photochemical models (Seinfeld et al., 1987) and has made several recommendations for model improvements which should be made in anticipation of and using the SCAQS data. These recommendataions are summarized in Section 6.5.1 below. Some of the modeling projects currently planned by the sponsors are summarized in Section 6.5.2.

6.5.1 Modeling Recommendations of the Model Working Group

Modeling Project 1: Improvements in Wind Field Descriptions. Currently, the major data inputs to primitive equation hydrodynamic models are synoptic geostrophic wind profiles (which can vary with time) and domain-scale initial profiles of temperature and moisture. These data are obtained from the NWS rawinsonde network which has a 12-hour temporal resolution and a spatial resolution on the order of 500 km. Given these initial domain-scale measurements, the primitive equation models calculate mesoscale fields of wind, temperature and moisture without mesoscale observational input. The high-quality SCAQS mesoscale observations can be used in conjunction with prognostic primitive-equation models. The resultant meteorological fields derived from the models should be superior to those obtained via either objective analysis of observations or from the model without such input data.

The SCAQS meteorological data can be used in two ways. In the first approach, the mesoscale model is run with the usual NWS derived initial conditions. Model results and observational data are then input together to an objective analysis algorithm which produces a set of "ultimate" gridded meteorological fields. Research is needed to determine the sensitivity of the analysis scheme to model assumptions and parameter specifications which govern the relative weighting of modeled and observed wind fields.

The second approach involves the assimilation of mesoscale observational information during the model run. Data assimilation techniques have previously been applied in "regional-scale" (domain scale of 2000 km, grid scale of 50 km) numerical simulations. In one technique, artificial terms are added to the prognostic momentum and/or heat equations to "nudge" the model fields toward observations. In another technique, variational procedures are used at specified intervals to minimize the differences between model and observations subject to specified constraints. The model, thus, is used as a sort of dynamic interpolator/extrapolator.

The horizontal scales (domain scale of 200 km, grid scale of 5-10 km) are much smaller in the SOCAB than in previous data assimilation experiments, the gradients within the flow are larger (e.g., sea breeze convergence zones, inversion layers), and the effects of complex terrain are more important. The completion of this project would determine which data can be effectively assimilated; usually, a choice must be made between wind and temperature data.

Modeling Project 2: Planetary Boundary Layer and Mixing Prediction. Planetary boundary layer (PBL)/inversion layer predictions by the numerical model need to be improved. Synoptic subsidence, which is a significant control on inversion height and strength is not included in current models. The behavior of the model planetary boundary layer height in complex terrain needs to be investigated and improved, especially if venting and recirculation of pollutants by slope flow circulations is of interest. The current formulation, based on the results of Deardorff's flat-terrain large-eddy simulation, is questionable in complex terrain. Two-dimensional simulations would be performed in this project to test improved PBL prediction techniques against SCAQS measurements. The mathematical descriptions would ultimately be applicable to three-dimensional simulations.

Modeling Project 3: Air Quality Model Testing. Mesoscale model input (winds and/or mixing heights) in air quality models (e.g., the Urban Airshed Model, UAM) needs investigation. The vertical resolution in mesoscale meteorological simulations is usually higher than that customary in air quality modelling. The sensitivity of the UAM to improved vertical resolution, especially in highly sheared atmospheres, should be tested to determine the extent to which air quality predictions are improved. Also, tests of UAM sensitivity to wind inputs in sparse-observation subregions should be carried out; if such sensitivity is demonstrated, this might justify the incorporation of primitive-equation meteorological models into air quality models used for control strategy assessment.

Modeling Project 4: Gas-Phase Hydrocarbon/NO_x Chemistry Model Testing. Due to the intensive research efforts carried out over the past 10-15 years, the atmospheric chemistry of anthropogenic emissions is reasonably well known. Under U.S. EPA funding, two detailed chemical mechanisms have recently been developed, one by Environmental Research & Technology/Statewide Air Pollution Research Center (ERT/SAPRC) based upon the earlier SAPRC mechanism, and the other the Carbon Bond IV developed by Systems Applications, Inc. The general features of the chemistry of these two mechanisms, are similar, as expected since they are both based upon the laboratory kinetic, mechanistic and product data available. However, certain portions of the mechanisms, for example, those dealing with the aromatics chemistry, are different due to differing methods of parametizing these presently unknown reaction mechanisms. At the present time, the major areas of uncertainty in the chemical mechanisms are those concerning the reactions of the aromatic hydrocarbons, the reactions of the longer chain alkanes, and of the ozone-alkene reactions.

The complete chemical mechanisms must then be tested against environmental chamber data. Uncertainties in the chamber light intensities and spectral distributions, and in the chamber effects (for example, the chamber dependent radical source and NO_x and organic off-gasing rates), together with the uncertainties inherent in the environmental chamber data themselves, lead to additional overall uncertainties in the predictive abilities of the chemical mechanisms. At the present time, the two latest mechanisms (the ERT/SAPRC and the Carbon Bond IV) agree with the environmental chamber maximum ozone yields to within approximately 30 percent. With reanalysis to take into account a reevaluation of the light intensities and spectral distributions of the University of North Carolina chamber, this 30 percent scatter may be reduced somewhat.

When used in urban airshed computer models for hydrocarbon control strategy applications, however, these two chemical mechanisms lead to different conclusions with regard to emissions reductions. SCAQS data should be used to compare against the intermediate reaction products of these mechanisms in order to resolve these differences.

Also, the performance of the several models which will be applied to and tested against SCAQS data should be compared. A protocol for such a comparison should be formulated, and the model applications should be designed such that a common set of performance measures is produced by each model.

Model Project 5: Transport/Deposition in Air Quality Models. A gap exists between the micrometeorology in air quality models and that in state-of-the-art planetary boundary layer models, and the treatment of micrometeorological phenomena in the air quality models applicable to the SOCAB should be improved. Dry deposition modules in these air quality models should be brought up to the most current level possible.

There is considerable room for improvement in the mixing layer determination and boundary-layer profiling in air quality assessment models. There also appears to be a need to adapt the models to more fully utilize the micrometeorological outputs from prognostic meteorological models. Improved micrometeorological data would improve the dry deposition velocities as well as the K_z profiles. SCAQS data should be used to test different mechanisms for prediciton accuracy and to estimate several of the parameters required by the mechanisms.

Modeling Project 6: Emissions Inventory Grid Resolution. Simulations should be performed to assess the effect of the emissions inventory grid resolution on predicted concentrations. Grid nesting might be examined should finer resolution be called for in certain areas of the region.

Modeling Project 7: Aerosols and Acidic Species Model Development. Prediction of PM-10, fine particles, visibility and acidic species will require a model capable of relating gaseous and particulate emissions to gaseous acidic substances, and particulate sulfate, nitrate, organics, and elemental carbon, ammonium, water, and metal and soil compound concentrations. There does not currently exist a three-dimensional model capable of predicting the airborne concentration of gaseous, particulate, and aqueous-phase acidic species.

The component parts are now in place to proceed with the development of a three-dimensional comprehensive acid deposition model. To produce such a model, the approach is to integrate modules for aerosol chemistry and physics and aqueous-phase chemistry (cloudwater, rain or fog) into a three-dimensional gas-phase photochemical model. The sub-model(s) becomes a computation carried out in each grid cell of the full model, updated at each time step akin to the gas-phase chemical kinetics.

The potential importance of aqueous-phase pathways leading to the incorporation of sulfate, nitrate, and acidity in cloudwater, fogwater, and rain is widely recognized. In order to determine the most important of these pathways to be included in a wet deposition module, a comprehensive aqueous-phase chemical mechanism must be assembled and tested over a wide range of environmental conditions. SCAQS data would be used for testing purposes.

Important areas that need to be examined are organic peroxide chemistry, trace metal catalyzed reactions, and free radical chemistry. In addition, the role of aqueous-phase organic chemistry in determining the chemical composition of cloudwater and rain is not adequately understood. These areas must be reviewed and reassessed at regular intervals.

6.5.2 Modeling Projects Planned by the Sponsors

Some of the modeling projects currently planned by the sponsors are outlined below.

- Southern California Edison may use the meteorological measurements to evaluate a prognostic one-layer sea breeze model which was developed by the University of Washington and the Pielke (1984) primitive equations model to describe wind fields. SCE will also use SCAQS data for continuing its organic aerosol receptor modeling project, and as input to and testing of the PLMSTAR (Godden and Lurmann, 1983) photochemical model.

- The Research Division of the Air Resources Board is sponsoring the California Institute of Technology (Dr. John Seinfeld) to develop model components for the formation and dynamics of aerosols for inclusion in the Caltech urban photochemical model. In addition, Dr. Seinfeld will use the SCAQS data to evaluate the ability to simulate ozone photochemistry of a hierarchy of models and to assess the ability of his aerosol model components to predict the size, spatial and temporal distribution, and dependence on the gas phase of the SOCAB aerosol.

- The Technical Support Division (TSD) of the Air Resources Board would like to use the SCAQS data in the development of control strategies for ozone and PM-10. Over the long-term, the data will also be useful for visibility, acid deposition, and toxic substance control strategy development as well. Specifically, given adequate resources, the TSD control strategy development tasks for O_3 and PM-10 would include the following steps.

  -- Identify the characteristics of ozone and PM-10 episodes, and construct annual frequency distributions of these episodes.

  -- Simulate the flow fields using wind models, and compare performance against wind measurements and tracer concentrations measured in SCAQS. Evaluate the performance of wind field models and improve them.

  -- Develop a grid model with improved treatments of atmospheric chemical and physical processes, dry deposition, diffusion processes, and formation of nitrate, sulfate, and organic particles.

  -- Apply the wind field and chemistry model to initial and boundary conditions acquired during SCAQS, and compare calculated values with those measured at SCAQS stations throughout the SOCAB. Evaluate the need for further model development.

  -- Develop effectiveness factors for controls on particulate matter NO_x, SO_x, and hydrocarbons for each source type and receptor location.

  -- Use cost-of-control figures, effectiveness factors, and PM-10 and ozone episode frequency distributions to derive cost-effective control strategies to reduce ozone levels and PM-10 levels throughout the SOCAB.

- General Motors Research Laboratories (GMR) will apply factor analysis techniques to estimate the major source contributions to PM-10 and PM-2.5 using the aerosol chemical composition data, routine gaseous pollutant data, meteorological data, emissions inventories, and emissions characterization results. GMR will also employ empirical and theoretical modeling to relate the chemical composition of the aerosol to the SCAQS visibility measurements using the chemical composition, impactor, visibility, and meteorological data. The mutagenic activity measurements will also be used in source apportionment models to identify their origins.

6.6 SYNTHESIS AND INTEGRATION OF SCAQS DATA INTERPRETATION RESULTS

The projects listed in Section 6.4 and 6.5 represent self-contained studies, yet to fully profit from the wealth of information in the SCAQS data, the results must be synthesized and presented in a cohesive form. A separate project, headed by the Data Analysis Coordinator, would provide this synthesis in the following manner. Projects 1.1, 1.2, and 1.3 would be performed first, and this descriptive information would be made available to all other researchers. Each researcher would use this information plus whatever he needs from the entire data base to perform the tasks specific to the project statement. All researchers would be known to each other, and communications among researchers would be encouraged, but not required. The Data Analysis Coordinator would accommodate the needs of each researcher with respect to data needs and would act as a clearinghouse for information. After approximately two-thirds of the resources in each project have been expended, each researcher would document his results in writing and present them at a workshop. Interpretive results of one project which would enhance other projects would be identified at the workshop and collaborative agreements between researchers would be established. After this workshop, researchers would finish the final third of their projects with the appropriate incorporation of the work of others. The Data Analysis Coordinator would synthesize the papers and discussions of the workshop into a draft technical paper in the mode of Hidy et al. (1975). The paper would be reviewed by all participants and revised as appropriate. A general symposium would be established for the presentation of the final work, which would be peer-reviewed by external reviewers and published as a book or in one of the technical journals.

7. PROGRAM MANAGEMENT PLAN AND SCHEDULE

7.1 MANAGEMENT STRUCTURE

The SCAQS management structure is outlined in Figure 7-1. The major management functions are funded by ARB, and the Program Coordinator (PC) reports to the ARB. In a cooperative study such as this, however, the PC cannot have direct management authority over all phases of the study. In essence, his job is to manage by consensus, since direct fiscal responsibility will remain with ARB and the other sponsors for their respective contracts.

The PC receives guidance from a Management Advisory Group (MAG) consisting of representatives of the sponsors and technical advisors selected by the sponsors. The MAG decides the technical direction for the study. The principal role of the MAG is to ensure that the objectives of the study coincide with the needs of the sponsors and that the program plan is technically sound and is adequate to meet the objectives. This program plan has been prepared with the advice and approval of the MAG.

The PC works with the Field, Data, and Analysis Managers and ARB staff as a team to coordinate the activities of other ARB contractors. Although the PC does not have direct authority to manage the activities of participants funded by other sponsors, their decision to participate in the study and to follow the program plan should give the PC enough leverage to adequately manage the study.

During the study, the PC is responsible for the following tasks:

- Overall program coordination to keep the study on schedule and to resolve conflicts.
- Coordination of ARB contractor efforts.
- Coordination with the emissions contractor(s) and other complementary efforts.
- Coordination of quality assurance activities.
- Selection of sampling days.
- Monitoring achievement of defined milestones and periodic budgetary reviews to assure that the study goals can be met with the resources available.
- Periodic revision of the program plan to take into account technical, logistical, or budgetary issues or problems which might arise.
- Preparation of short periodic summaries of activities.
- Preparation of progress reports summarizing the progress, preliminary results, and conclusions to date of the study. These reports will require technical input from all participants.
- Coordination of periodic meetings of investigators.

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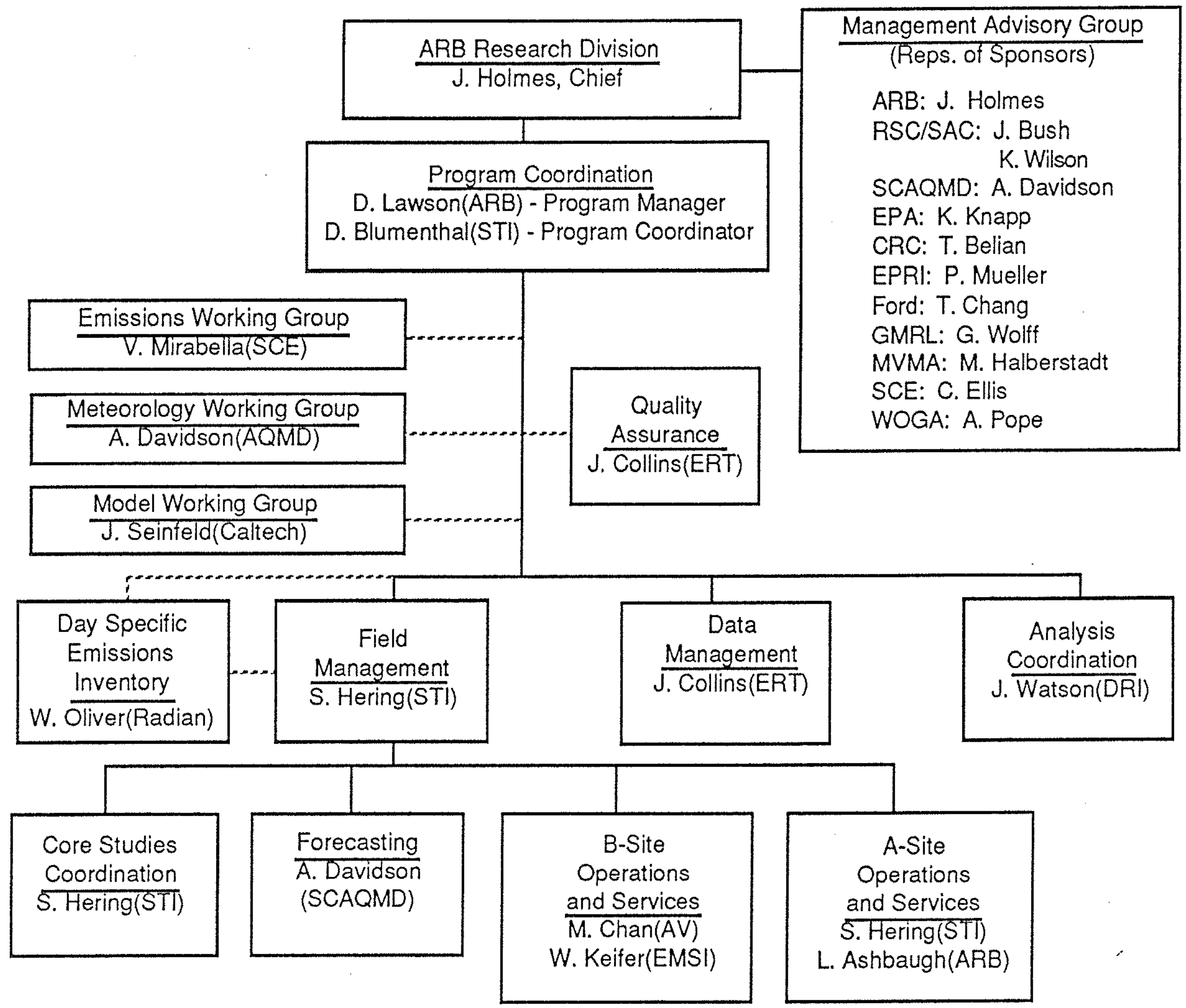


FIGURE 7-1. SCAQS Organization Chart

- Coordination of a technical session or meeting at which the final study results will be presented and coordination of the submittal of manuscripts for back-to-back publication in a selected journal.

- Preparation of a final summary report which presents the results and conclusions of the study and provides a bibliography of SCAQS publications. The last two tasks are not funded at this time and may be performed by ARB staff.

The roles of the Field, Data, and Analysis Managers shown in Figure 7-1 have been described in previous sections. The Field Manager (FM) will prepare a measurement protocol with the input and review of the participants. The FM will be responsible for coordination of forecasting activities, assessing sampling readiness and for the day-to-day interactions with the field participants. The FM will also coordinate the preparation and upkeep of the A- and B-sites and related facilities. The actual work, however, will be performed by other contractors as indicated in Figure 7-1.

The DM will be responsible for the assembly, archiving, and distribution of all study data. The DM will also assemble and format data from supplementary sources with the help of the ARB staff.

The Analysis Coordinator (AC) will work with the investigators to assure that all objectives are addressed by one or more analysis efforts and to identify and eliminate redundant efforts. The AC will facilitate communications between investigators and encourage synergistic efforts.

Some boxes in Figure 7-1 are connected by dashed lines, indicating a consultative or coordination function. The Quality Assurance (QA) function is separate from the measurement functions and reports its results directly to the PC. The QA effort is coordinated by a QA Manager, but the actual QA work will be split among more than one contractor or sponsor. The activities of the QA Manager are defined in Section 4. His efforts are coordinated by the PC, but his reports will be independent documents from the reports prepared by the PC. Copies of the QA reports will be provided to participants and sponsors. It is the responsibility of the PC to find a way to remedy any serious program deficiencies identified by the QA Manager.

The Emissions, Meteorology, and Model Working Groups are independent committees of participants and sponsors. Some members of these groups are planning research efforts which provide input to or make use of the SCAQS data base. The Emissions and Model Working Groups have been set up to be complementary to SCAQS and their functions will continue beyond the SCAQS field program. The function of the Meteorology Working Group has been primarily to help design the SCAQS meteorology measurements, the forecast protocol and to help focus the tracer studies. The input of all three groups has been required in the design of SCAQS to ensure that the objectives can be met. The working groups provide their recommendations and input directly to the Program Coordinator and the MAG.

The day-specific emissions inventory function shown on Figure 7-1 is actually an activity which is designed and coordinated by the Emissions Working Group. The inventory contractor must coordinate closely with the field manager so that he is aware of the sampling schedule and is prepared to obtain the necessary real-time emissions information on the intensive study days.

Although the major elements of the management structure have been outlined above, most of the project work will be performed by contractors or participating sponsors. The study will involve more than 50 separate contracted tasks. These tasks, their estimated costs, and their sponsors are listed in Section 8.

7.2 SCHEDULE

The SCAQS schedule is outlined in Figure 7-2. We expect the dates and durations to be modified depending on climatological and fiscal considerations. The dates shown here are to be considered only as general guidelines.

7.3 REPORTS AND PRESENTATIONS

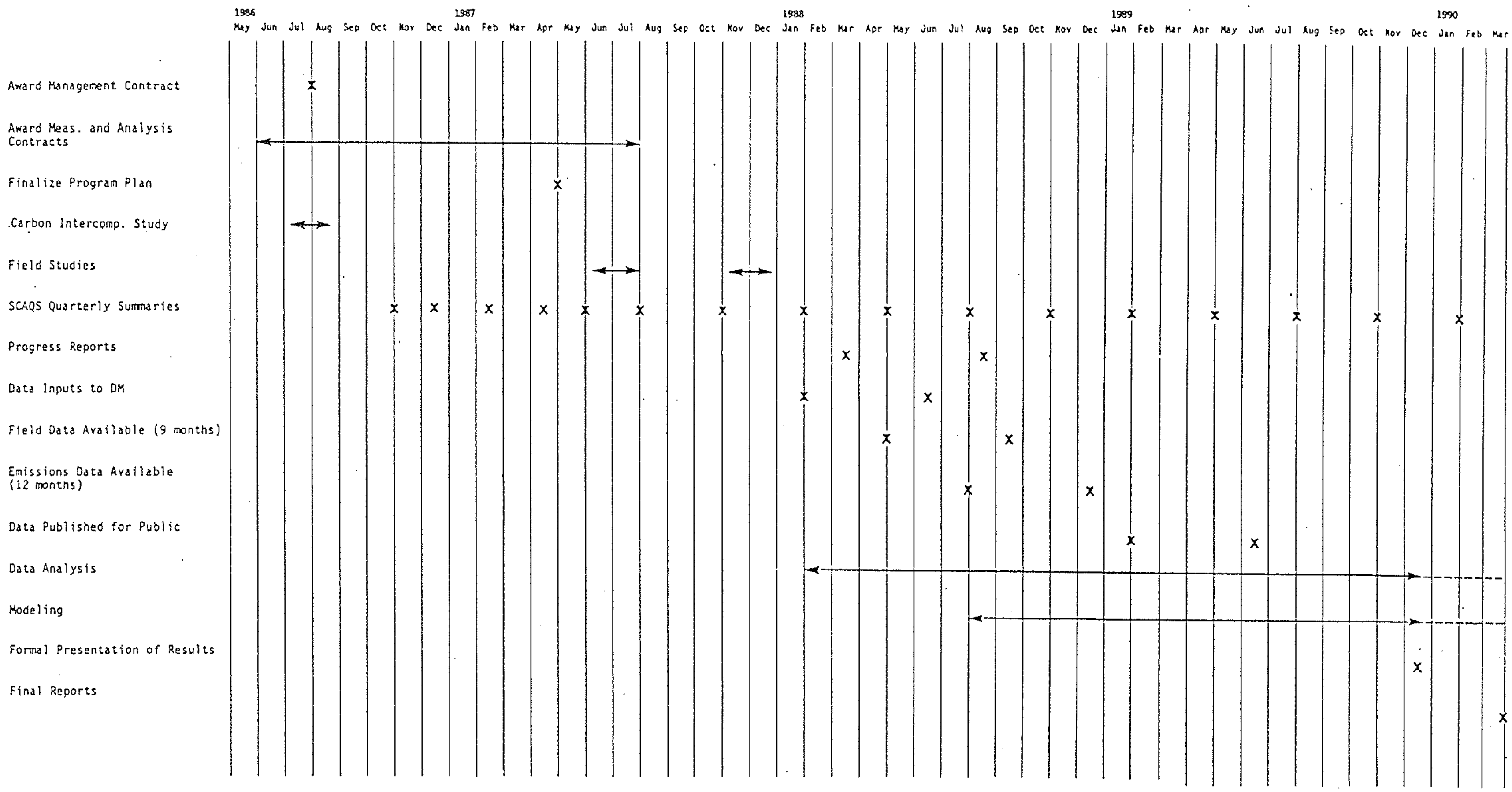
One way to keep a study on schedule and to encourage productive results is to schedule periodic reports and presentations which summarize the results and conclusions. The following reports and presentations should be prepared as part of the study.

- Project Protocols - These should list the measurements to be made, the groups which perform each measurement, the logistical requirements of the measurement groups, the services to be provided by the Field Manager, summaries of the QC and QA activities, the types of data to be obtained, the formats in which data are to be submitted to the Data Manager, and the formats in which data will be available from the Data Manager.

- Periodic Summary of Activities - The Program Coordinator will prepare brief periodic summaries of project activities including meetings of the MAG and participants. In preparing the summaries, the PC will review the routine monthly or quarterly progress reports of the participants and identify any instances for which the work plan or schedule are not being met.

- Progress Reports - These reports will be prepared by the Program Coordinator with input from all participants. The summer and fall field study reports will summarize what happened during the field programs and include preliminary operating information on the major SCAQS equipment, preliminary data capture rates for data already reported, and information on the status and expected availability of all data for the field program. The purpose of these progress reports is to communicate what has been learned from the study to the sponsors in an ongoing fashion. It will be expected that all participants prepare their own reports which can then be used by the Program Coordinator in the preparation of his summary report.

- Quality Audit Reports - Quality audit reports will be prepared within two months after each field program which document the QC and QA activities of the study and which describe the results of the audits and performance tests.


1986
May Jun Jul Aug Sep Oct Nov Dec
1987
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1988
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1989
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1990
Jan Feb Mar
Award Management Contract
Award Meas. and Analysis Contracts
Finalize Program Plan
Carbon Intercomp. Study
Field Studies
SCAQS Quarterly Summaries
Progress Reports
Data Inputs to DM
Field Data Available (9 months)
Emissions Data Available (12 months)
Data Published for Public
Data Analysis
Modeling
Formal Presentation of Results
Final Reports

- Data Summary Reports - These will be prepared by the Data Manager within 12 months after each field program. They will inventory the data available, document the data formats, and outline the procedures for accessing the data. The reports will also document the QA procedures and assess the validity, accuracy, and potential sources of error for the various portions of the data base.

- Data Base - The Data Manager will compile all data received into an easily accessible and reproducible form and make the data available to ARB and to all participants and sponsors within 15 months after the end of each field program. This data base and the data summary report will be made available to the public approximately 18 months after completion of each field study period.

- Emissions Reports - Within one year after each field program, the emissions contractor will report the results of his day-specific emissions inventory for the period. By the end of 1990, members of the EWG will prepare a formal 1987 emissions inventory for the study area. This report should document the procedures used to prepare the inventory and present graphic and tabular summaries. It should be accompanied by a data tape which includes the gridded, time-resolved emissions for the study days and by documentation of the data formats. Other analyses which are part of the emissions contracts should also be reported.

- Meeting Presentations - Within about 18-24 months of the end of the last field program, a session at a technical meeting should be organized for the presentation of the study results. Each participant who is responsible for some aspect of the data analysis will be expected to present his results. The manuscripts from the session should also be submitted to a technical journal. It is expected that other presentations will be made at earlier times as results become available.

- Final Reports - Each participant should prepare a final report which documents his work and summarizes his results and conclusions. The Program Coordinator should prepare a final report which describes all phases of the study and summarizes the results and conclusions.

8. SCAQS FUNDING

SCAQS is a cooperative study which is being funded by many different government agencies, industry groups, and individual corporate sponsors. These include the California Air Resources Board (ARB), the Environmental Protection Agency (EPA), the South Coast Air Quality Management District (SCAQMD), the Coordinating Research Council (CRC), the Electric Power Research Institute (EPRI), the Ford Motor Company, the General Motors Research Laboratories (GMRL), the Motor Vehicle Manufacturers Association (MVMA), Southern California Edison (SCE), and the Western Oil and Gas Association (WOGA). The overall project is estimated to cost about nine million dollars. This estimate does not include future data analysis or modeling efforts.

Figure 8-1 gives a short summary of the contributions of the various sponsors. Figures 8-2 through 8-4 give a more detailed listing of individual contracts and in-kind contributions. The bars in Figures 8-2 through 8-4 show the general time scales of the contracts. The text around the bars indicates the organization performing the work, the principal investigator, the sponsoring organization, the contract manager, and the approximate cost of the contract or in-kind service. Since the study is in constant flux, some of the details in Figures 8-2 through 8-4 may change.

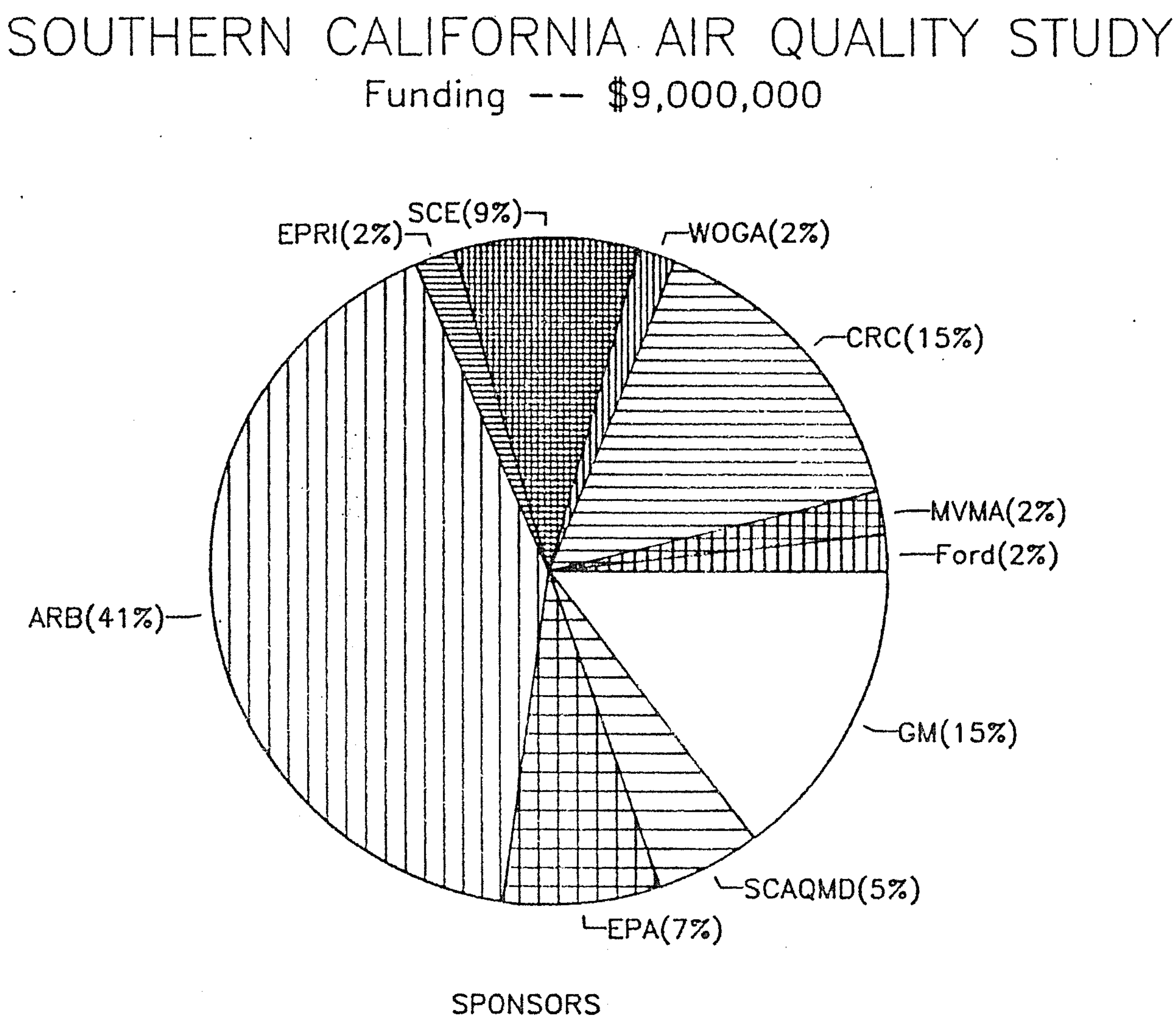


Figure 8-1. Summary of SCAQS Funding

Figure 8-2. SCAQS Core Program

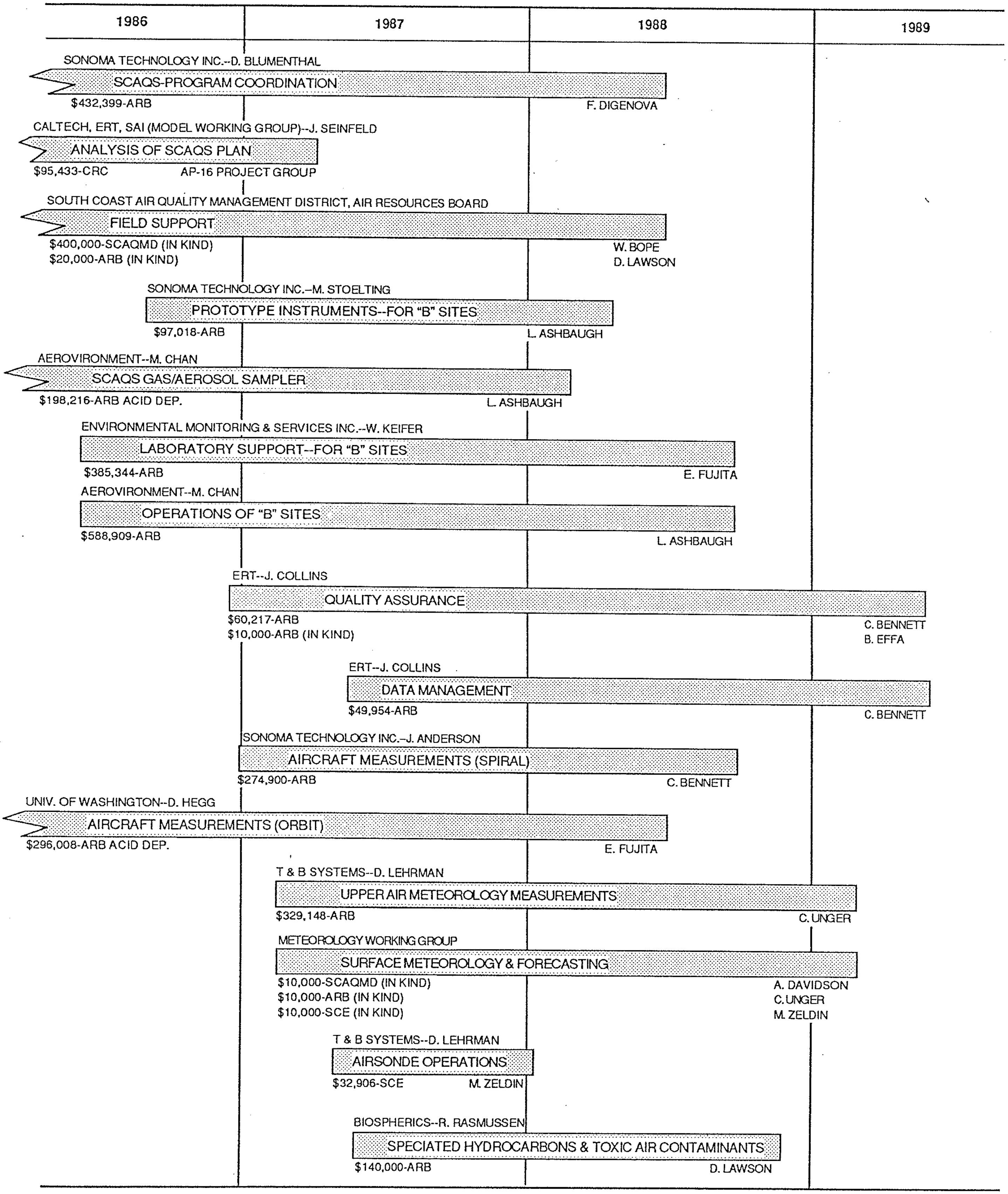


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Figure 8-2. SCAQS Core Program

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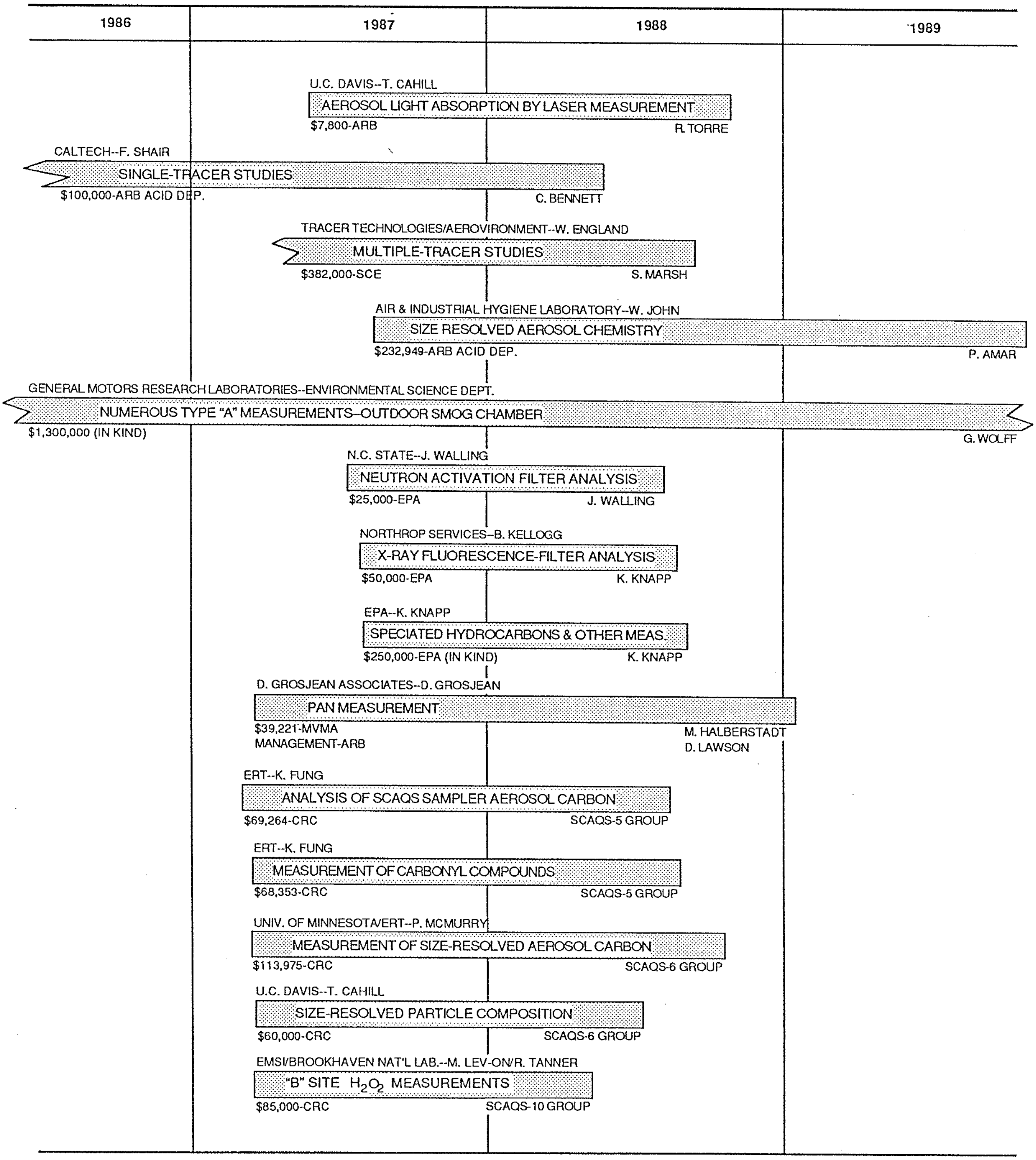

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Figure 8-3. SCAQS A-Site Studies

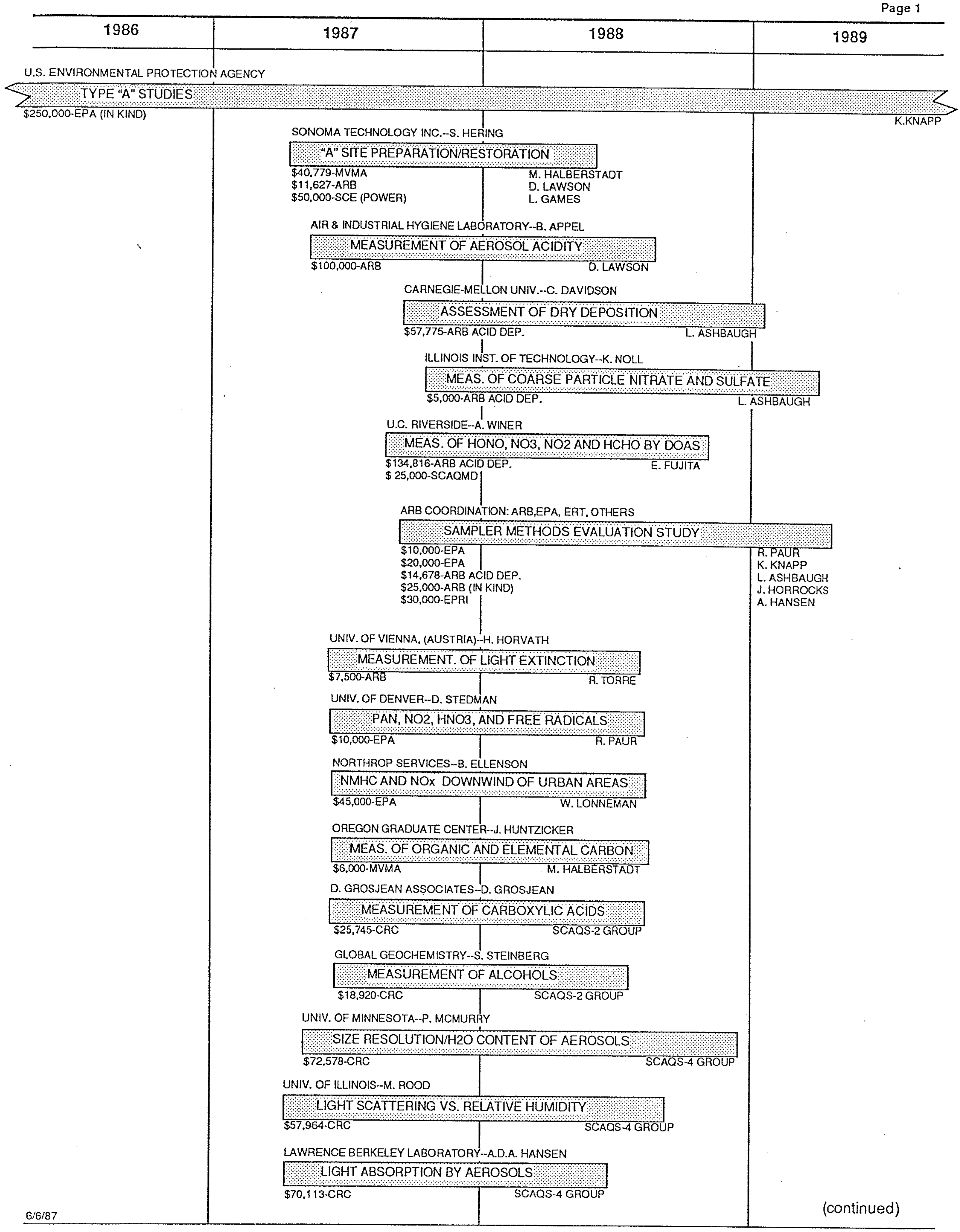

Figure 8-3. SCAQS A-Site Studies

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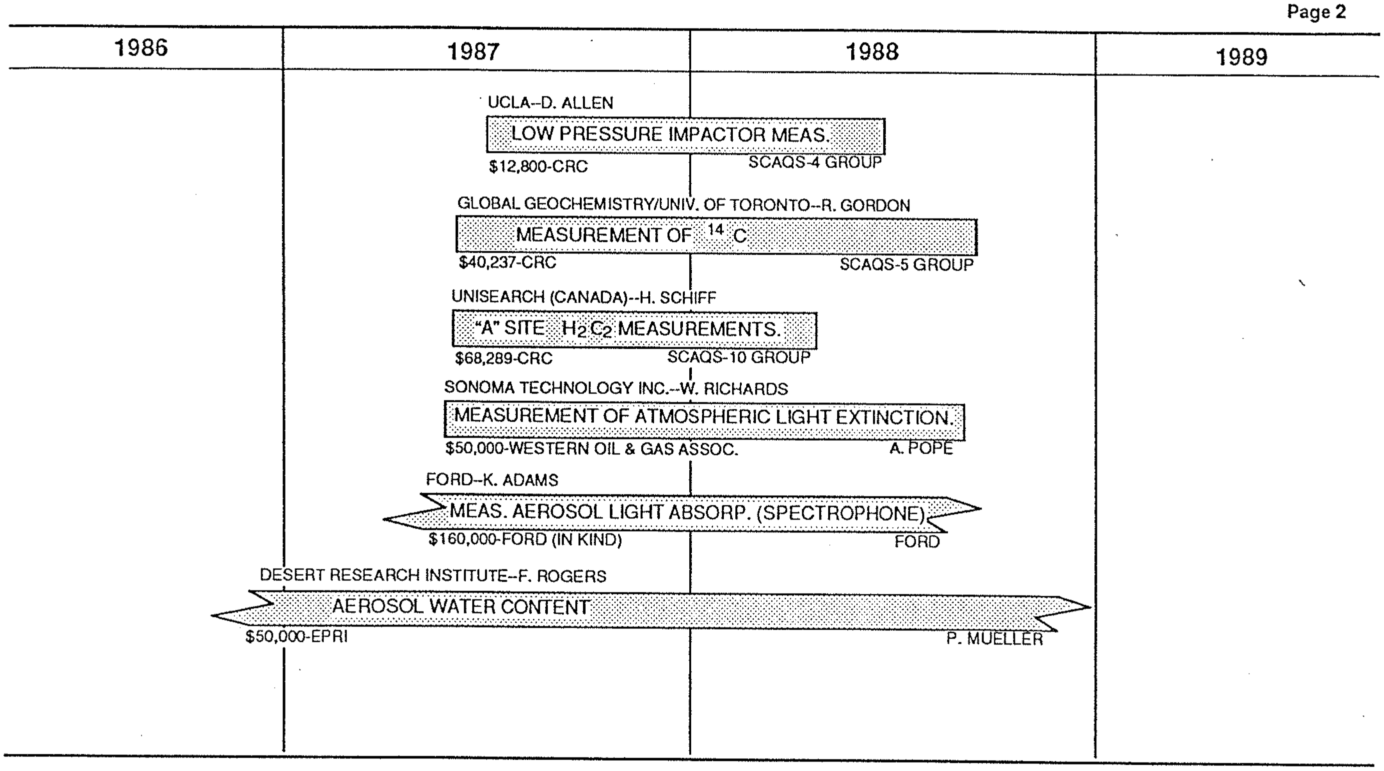
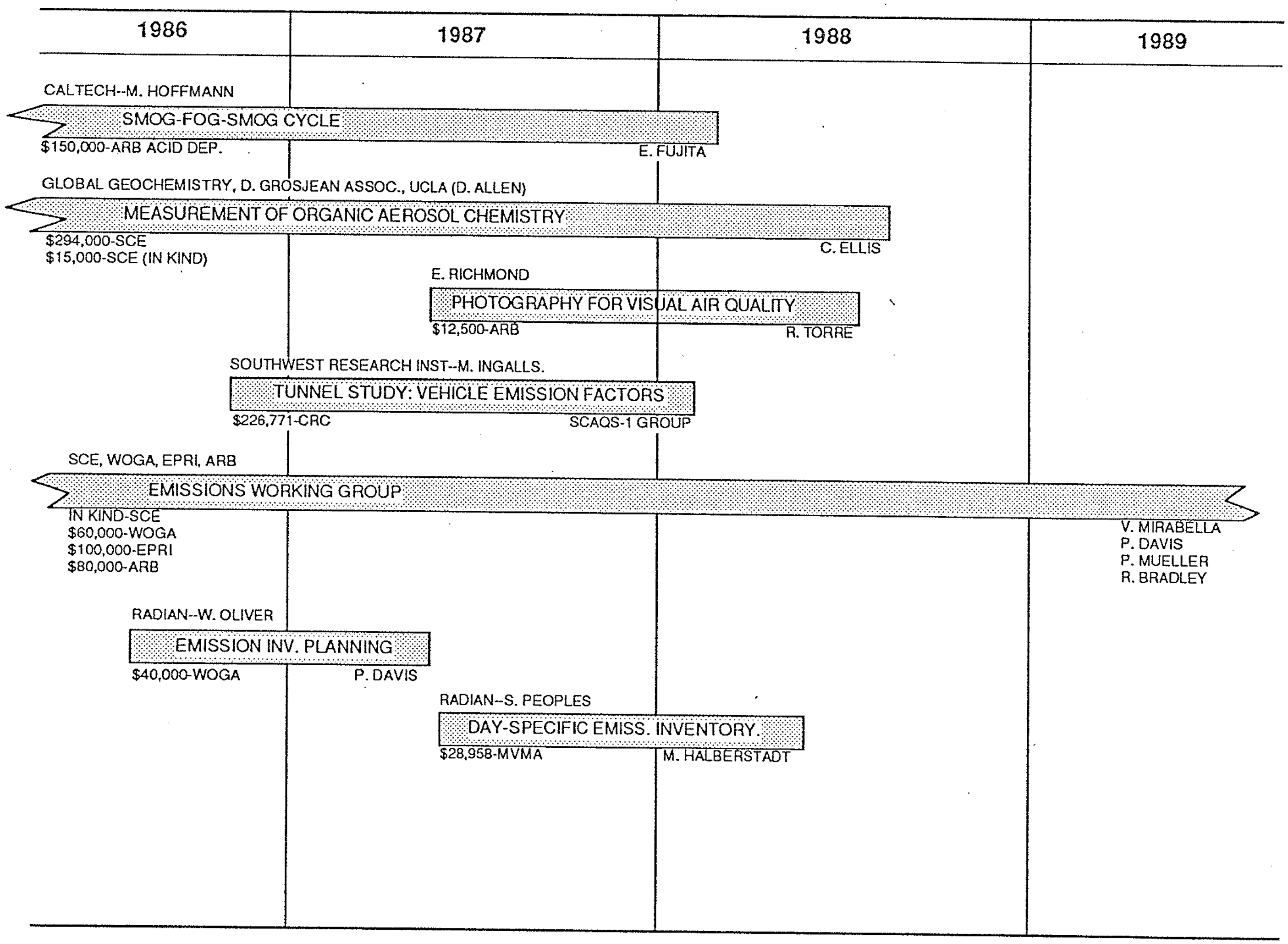


Figure 8-4. SCAQS Additional Studies



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